



SURVEY NOTES

formerly QUARTERLY REVIEW

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Service to the State of Utah

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Going Deeper . . .

UTAH DEPTH RECORD BROKEN

Utah's record for deep drilling, set in 1975, was broken by CIG Exploration in June 1976 at its #1 Cook-C test, NW¼SE¼ sec. 17, T. 3 N., R. 15 E., Summit County. At a depth of 21,405 feet, the operator cemented 21,380 feet of liner in formations of Pennsylvanian age. The well was last reported at 21,786 feet, possibly in Mississippian formations. Electrical logs had been run at 21,617 feet.

The former depth record was a 20,450-foot test drilled by Phillips Petroleum near Mayfield, Sanpete County. The new record well is on the north flank of the Uinta Mountains about 3 miles east of the Bridger Lake gas field and less than a mile from the Wyoming line.

CIG Exploration is a subsidiary of Colorado Interstate Gas Company of Colorado Springs. The upper part of the new record holder was drilled by Phillips Petroleum.

WATER LEVELS OF GREAT SALT LAKE

Great Salt Lake levels recorded (in feet above sea level) by the USGS are:

Date	Boat harbor (south arm)	Saline (north arm)
May 1	4,202.10	4,200.15
May 15	4,202.20	4,200.15
June 1	4,202.25	4,200.30
June 15	4,202.00	4,200.20
July 1	4,201.85	4,200.15
July 15	4,201.55	4,200.05

The high level, 4,202.25, reached on June 1 was 0.70 foot higher than the 1975 high level reached on June 15, 1975.

Research Section . . .

UGMS AND GREAT SALT LAKE

This already notable bicentennial year marks a progressive time for Utah and for research on the Great Salt Lake. Utah has won another in a lengthy series of legal battles with the federal government and finally gained complete ownership of the lake and its adjacent lands up to the surveyed meander line. The newly created Division of Great Salt Lake, which coordinates the lake activities of other state agencies, has finished its first year of operation. The Research Section of the Utah Geological and Mineral Survey is initiating new programs in its on-going studies of the lake.

Under the direction of section chief, Dr. J. Wallace Gwynn, UGMS' Research Section has built and placed an instrument tower in the lake, is studying the bottom profile in the lake's north arm, and is introducing the brine sampling program to the computer age. Walter M. Katzenberger, UGMS Aquatic Operations and Maintenance Specialist, was responsible for the final design and construction of the tower and selected the location where it is placed.

On April 19, the instrument tower was airlifted (see *Survey Notes*, Vol. 10, No. 2, May 1976) by helicopter to its present location approximately 2 miles northwest of Silver Sands Marina. Standing in about 30 feet of water, the tower has a 64 square-foot working platform at its top. Since April the tower has proved its hardiness by surviving several storms that have swept over the lake and caused extensive damage to shoreline facilities. The tower will provide a stable base on which to mount a variety of hydrological and meteorological instruments and from which to conduct other lake-testing programs. Much of the cost of the tower and the instruments has been financed by the Division of Great Salt Lake.



View of Great Salt Lake taken from Skylab 3 in September 1973. Causeway separates north arm of lake (light area) from south arm (dark area). P = Promontory Point; A = Antelope Island; S = Stansbury Island. (photo courtesy of NASA Skylab Program)

Presently the tower will be outfitted with the following hydrological instruments: a wave and tide gauge, a current speed and direction meter, a water level indicator to record fluctuations in the halocline (the interface between the deep, dense brine in the south arm of the lake and the less dense brine above it), and a series of vertical

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SURVEY RELEASES

LATEST STUDIES

The latest publication of the Utah Geological and Mineral Survey is available through the UGMS Publication Sales Office, 606 Black Hawk Way, Salt Lake City, Utah 84108. When ordering by mail, add 10% for handling and mailing charges.

Bulletin 109, *Allosaurus Fragilis: A Revised Osteology*, by James H. Madsen, Jr. (\$6.50). Bulletin 109 is a restudy of earlier work on the relatively well-known, but inadequately described, carnivorous dinosaur, *Allosaurus fragilis*, from the Late Jurassic Morrison Formation. The author has done an in-depth study, made possible by the comprehensive collection of bones assembled by him from the Cleveland-Lloyd Dinosaur Quarry. This profusely illustrated work is designed as a basic reference for others involved in studies of the theropod dinosaurs. Bulletin 109 contains 163 pages, 8 tables, 26 figures, and 55 plates.

UGMS has its unpublished Reports of Investigation on open-file. These recent reports may be examined at the UGMS offices.

Report of Investigation No. 105, *Preliminary Geologic Reconnaissance of Timber Lake Subdivision, Plat No. 15, Wasatch County, Utah*, by Muhammed A. Raja, January 1976, 4 p.

Report of Investigation No. 106, *Preliminary Geologic Reconnaissance of Six Southern Utah Subdivisions*, by Bruce N. Kaliser, February 1976, 5 p.

Report of Investigation No. 107, *Geologic Reconnaissance of the Site for the Sevier Valley Technical College with Notes of Archaeological Significance*, by Bruce N. Kaliser, March 1976, 5 p.

Report of Investigation No. 108, *Final Report to the U. S. Geological Survey Earthquake Hazard Reduction Program*, by Bruce N. Kaliser, May 1976, 231 p.

GREAT SALT LAKE

(continued from page 1)

temperature probes to measure the lake's temperature gradient and annual variations. The meteorological instruments include a wind speed and direction meter, a meteorograph (air temperature, humidity, and barometric pressure), a rain gauge, and an evaporation pan. All instruments have been set up to furnish a continuous 30-day record. From the tower, researchers will also be examining other phenomena of the lake.

During May and June, bottom profiles were taken on the north arm of the lake with a fathometer mounted in the 20-foot UGMS boat. The accumulated data will be used to compute the volume of the north arm. In 1975 UGMS published Map 38, *Navigational Chart of the Great Salt Lake South Arm*. The data from this map has been used to construct new area and volume curves for the south arm of the lake, which are needed to calculate the mineral content of the brine and to provide information for other lake-related studies.

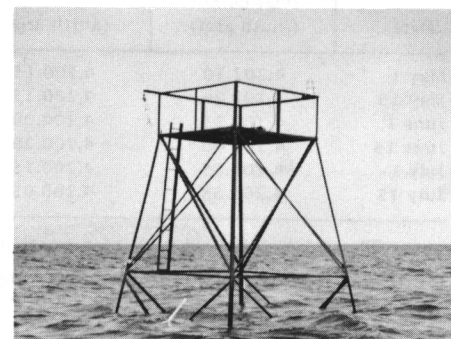
Brine samples are taken from the lake four times a year, during June, August, October, and January—the months that correspond to the high, low,

and intermediate water elevations of the lake in a year. Samples from the surface and from 5-foot increments to the bottom are analyzed for their contents of magnesium, potassium, sodium, calcium, sulfate, chloride, bromine, boron, and lithium. At the time of sampling, the depth of the halocline, water temperature and density, and any unusual observations are recorded. UGMS has a continuous record of brine samples and chemistry for the lake since 1966, most of which has been put on computer cards and tape for ready access and data manipulation. This continuous record provides data covering lake levels from the low of 4,194 feet (only 3 feet above the historic low) to the present 47 year high of 4,202 feet.

For the future, UGMS' research on the Great Salt Lake is expected to intensify as programs are expanded and new areas are explored. Possible research may include the distribution and movement of heavy metals in the lake, corrosion problems in the lake, the relationship between the brines above and below the halocline, bottom sediments, the energy potential of the lake, and the industrial potential of the brines. UGMS is working to discover the multitude of secrets held by this unique and fascinating body of water.



Above: The UGMS Research Section chat during a planning session. They are (from right to left) Dr. J. Wallace Gwynn, section chief; Walter M. Katzenberger, aquatic operations specialist; Michael T. Bradford, operations assistant; and Carol A. Petersen, geologist. Above right: UGMS' Research Section uses the 42-foot G. K. Gilbert in a variety of operations on the Great Salt Lake. The craft has been engaged in fathometer studies of the South Arm, in coring the salt crust in the North Arm, and in the ongoing brine-sampling program. Bottom right: The top twelve feet of the UGMS tower jut out from the Great Salt Lake. Instruments to be placed on the deck will soon be recording hydrological and meteorological data. (UGMS photos)



UTAH MINERAL INDUSTRY ACTIVITY FOR 1975

by Carlton H. Stowe¹

VALUE OF MINERAL PRODUCTION

The value of Utah's mineral production decreased from \$952,045,000 in 1974 to \$938,656,000 in 1975 (table 1), but this was only the second year that production exceeded \$900,000,000 (figure 1). The decrease resulted mainly from less copper production and a decrease in copper prices from \$1.77 per pound to about \$1.63.

When adjusted to the 1967 constant dollar (figure 1), the value of Utah's mineral production is seen to have reached peaks in 1970 and again in 1974. However, only modest gains have been made over average values recorded for 1958 to 1966. Dramatic value increases are largely due to inflation.

Large gains were recorded for mineral fuels—petroleum, natural gas and coal—both in quantity and value of production. Of the metals only lead and zinc showed increases in quantity and value of production. In nonmetals, production generally decreased, but dollar values increased indicating an inflation of values per unit.

LAND OWNERSHIP²

At statehood Utah was entitled to four "school" sections in each township. In the Wasatch Front area much of this land had already been acquired by individuals before statehood, so the state's school acreage was increased in other areas to compensate for the deficiency. Also, Utah has been entitled to select like amounts of land in lieu of those lost to various federal reservations (national parks, monuments and wildlife refuges, bombing ranges, and others) created after statehood; but the process has been complex and slow, and the debt of "lieu land" owed to Utah is now

225,440 acres. About 157,000 acres of this deficiency is in the oil shale areas of eastern Utah's Uintah County and is in litigation between Utah and the United States.

Federal Lands³

The Federal government controls 66.6 percent of Utah lands excluding Indian lands. With Indian lands, the total is 70.9 percent. Agencies of the Department of the Interior (Bureau of Land Management, National Park Service, Bureau of Indian Affairs, and others) control about 28,000,000 acres, about 53.3 percent of Utah's land area (figure 2).

³ Source: U. S. Bureau of Land Management, *BLM Facts & Figures for Utah-1975*.

	Millions of acres	Percent of land area
Federal Lands		
National Resource Lands (mostly BLM)*	24.9	47.3
National Forests (Department of Agriculture)	8.0	15.3
National Parks, Monuments, etc.*	0.8	1.5
Department of Defense	1.2	2.3
Others	0.1	0.2
Total Federal Lands	35.0	66.6
Indian Reservations*	2.3	4.4
State	3.9	7.5
Private	11.3	21.5
Land area of Utah (52,541,440 acres)	52.5	100.0
Water area of Utah (1,804,800 acres)	1.8	
Total land and water area of Utah (54,346,240 acres)	54.3	

*Department of the Interior.

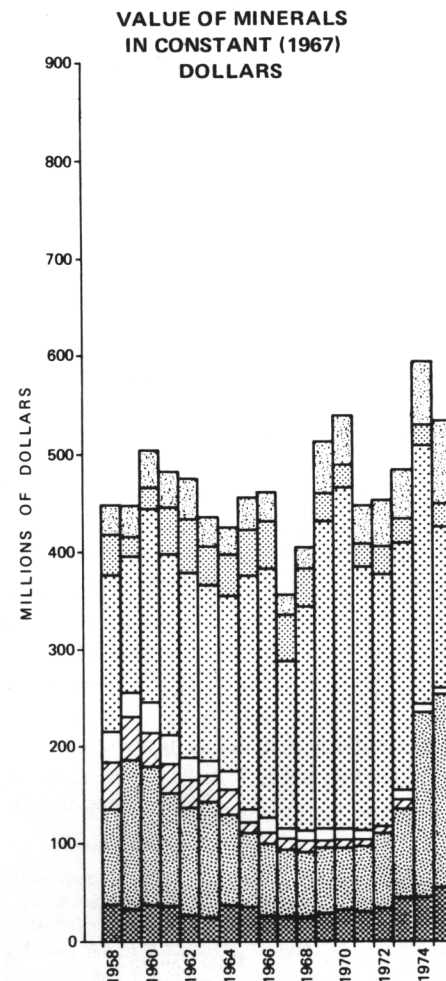
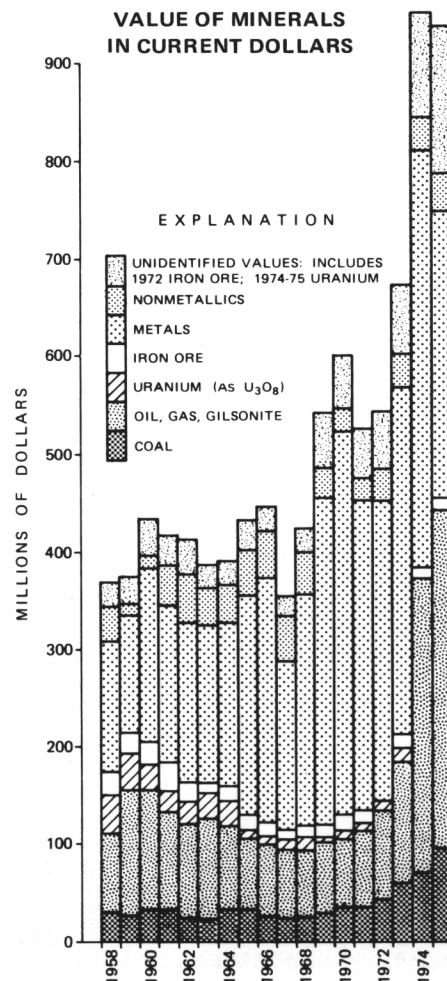


Figure 1. Value of Utah's mineral production, 1958 to 1975.

¹ Mineral Information Specialist, Utah Geological and Mineral Survey, Salt Lake City, Utah 84108.

² Source: U. S. Bureau of Land Management, *BLM Facts & Figures for Utah-1975* and Utah Division of Industrial Development, *Utah Facts*, 1976.

Table 1. Mineral production in Utah for 1974 and 1975.¹

Mineral	Unit of measurement	1974 ²		1975 ³	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Carbon dioxide (natural)	thousand cubic feet	93,751	6	100,000	6
Clay	thousand short tons	232	\$ 953	239	\$ 929
Coal (bituminous)	thousand short tons	5,858	71,699	6,900	96,600
Copper (recoverable content of ores, etc.)	short tons	230,593	356,497	180,515	231,059
Fluorspar	short tons	2,967	98	4	4
Gemstones	5	5	100	5	100
Gold (recoverable content of ores, etc.)	troy ounces	254,909	40,719	188,275	30,548
Gypsum	thousand short tons	248	1,076	290	1,551
Iron ore (usable)	thousand long tons, gross weight	1,808	14,016	1,455	12,746
Lead (recoverable content of ores, etc.)	short tons	10,510	4,729	11,775	5,087
Lime	thousand short tons	176	4,911	159	4,395
Natural gas	million cubic feet	50,522	20,815	58,888	35,274
Petroleum (crude)	thousand 42-gallon barrels	39,363	279,858	39,854	310,012
Pumice	thousand short tons	15	19	17	21
Salt	thousand short tons	771	7,321	651	8,382
Sand and gravel	thousand short tons	11,578	12,985	11,463	17,194
Silver (recoverable content of ores, etc.)	thousand troy ounces	3,208	15,109	2,733	12,105
Stone	thousand short tons	2,860	6,410	2,669	7,346
Zinc (recoverable content of ores, etc.)	short tons	12,619	9,060	18,850	14,741
Values of items that cannot be disclosed:					
Asphalt, beryllium, cement, magnesium chloride, magnesium compounds, molybdenum, natural gas liquids, phosphate rock, potassium salts, sodium sulfate, tungsten, uranium, vanadium, and values indicated by footnote. ⁴					
		6	105,664	6	150,560
Total		6	\$952,045	6	\$938,656

Source: U. S. Bureau of Mines annual preliminary report. Data compiled in cooperation with the Utah Geological and Mineral Survey.

¹ Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

² Final yearbook figures.

³ Preliminary figures.

⁴ Withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed."

⁵ Not available.

⁶ Not applicable.

The above apportionment of land ownership is based on the latest appraisal and calculations of the U. S. Bureau of Land Management and differs considerably from data published for previous years. There are some differences in the totals published by the BLM

and the Utah Division of Industrial Development.

In 1975, 71.5 percent of the total receipts from BLM-administered lands was directly derived from mineral leasing (table 2). The percentage has averaged

about 91.5 percent over the past 15 years and was changed by a sharp increase in receipts from the sale of lands and materials. The State of Utah receives 37.5 percent of the receipts from the mineral leasing fund and lesser percentages of income from other categories (table 3). Receipts totalled \$5,521,849 in 1975.

Table 2. Receipts from federally administered lands in Utah.

Fiscal year	All mineral receipts	Grazing	Lands and materials	Fees and services	Miscellaneous	Total
1901-1950	\$ 6,285,914	\$ 1,882,430	\$4,456,755	\$ 114,938	\$ 55,909	\$ 12,795,946
1951-1955	14,225,420	1,307,262	270,491	258,954	135,076	16,197,203
1956-1960	28,839,890	1,607,302	345,312	739,862	142,629	31,674,995
1961-1965	53,011,262	1,887,567	304,043	1,805,301	228,441	57,236,614
1966	9,700,560	358,629	55,149	363,238	24,382	10,501,958
1967	8,405,004	447,452	39,317	278,854	5,387	9,176,014
1968	7,987,914	415,003	24,317	283,325	7,995	8,718,554
1969	8,636,068	450,868	25,462	220,069	31,189	9,363,656
1970	8,646,079	568,647	149,036	157,608	41,257	9,562,627
1971	9,264,164	660,371	55,903	191,539	40,160	10,212,137
1972	10,035,591	731,342	85,638	336,086	55,637	11,244,294
1973	11,390,247	767,098	63,770	349,657	35,245	12,606,017
1974	13,355,492	973,619	26,800	579,925	39,579	14,975,415
1975	14,151,247	980,769	3,682,627	936,045	39,978	19,790,666
Total	\$203,934,852	\$13,038,359	\$9,584,620	\$6,615,401	\$882,864	\$234,056,096

Source: U. S. Bureau of Land Management, *BLM Facts & Figures for Utah—1975*.

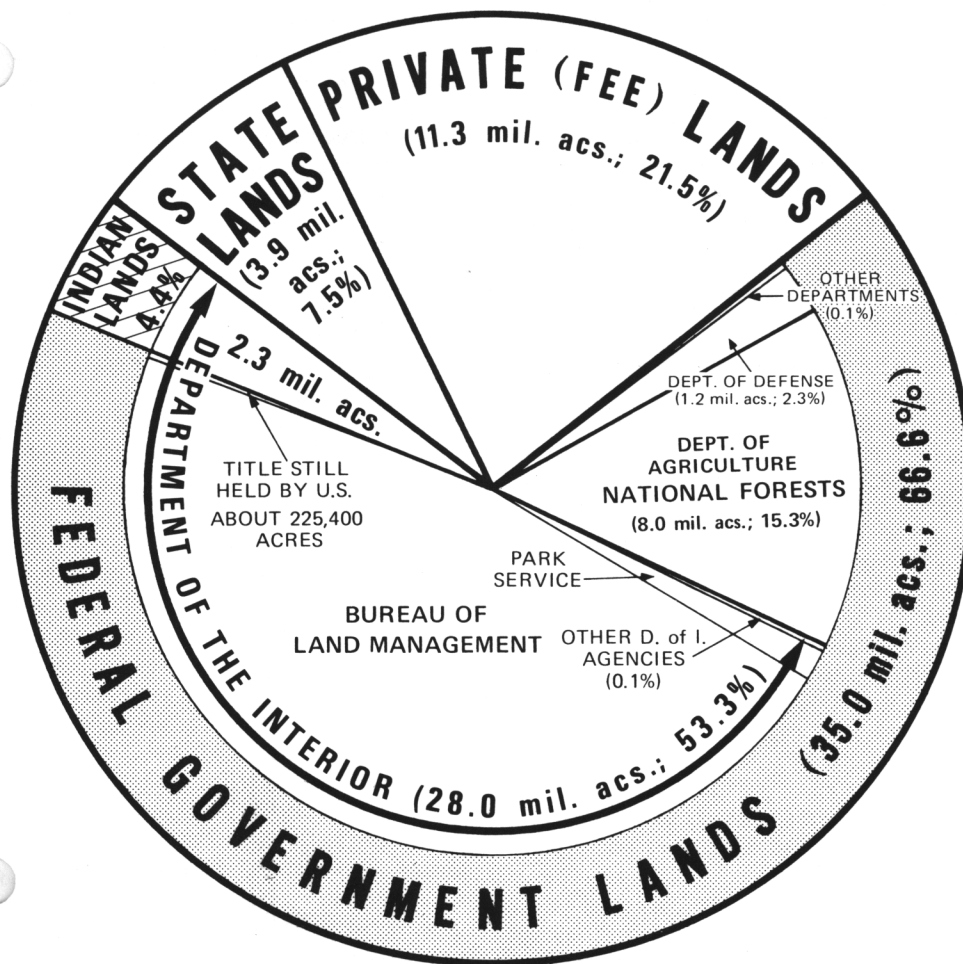


Figure 2. Utah land ownership, 1975.

State Lands⁴

The Division of State Lands reported that mineral lease revenue for

⁴Source: State of Utah, Division of State Lands, *Fiscal Report July 1, 1974 to June 30, 1975*.

1975 was \$5,205,677 compared with \$5,419,790 in 1974 (figure 3). Royalty revenue alone for the year was \$2,234,941 compared with \$1,173,586 in 1974, an increase of \$1,061,355. However, total collections during 1975 of \$11,982,049 is far short of the all-time

high in 1974 of \$22.6 million. Receipts totaled \$241,659 on sales of state-owned land, rights of way, timber sales, and grazing lease rentals. Other items such as sale contracts, loans, bond interests, and special-use leasing brought Utah \$4,299,772.

The state has 2,986,809 acres under oil and gas leases. Box Elder County leads in oil and gas leases with 414,496 acres. Grand County is second with 343,030 acres, followed by San Juan County's 288,356 acres and Uintah County's 251,649 acres. Other lease arrangements throughout the state are 432,506 acres for metalliferous minerals, 92,034 acres for nonmetallics, 49,898 acres for bituminous sands, 350,365 acres for coal, 222,541 acres for oil shale, 242,425 acres for salt, and 150,321 acres for geothermal energy.

EMPLOYMENT AND WAGES⁵

During 1974 the mineral industry employed 19,768 persons. Metal mining employment, consisting of those working in the iron ore, copper, lead and zinc, various metal ores, mining services and related occupations, again led with 7,680 employees. Wages in this group for the year were \$98,736,179 for an average monthly wage of \$1,071 per person. Approximately 2,574 persons were hired in the metal mining industries during 1974. The crude petroleum and natural gas industries had an annual payroll of \$33,554,900 for 2,807 employees; average monthly wage for the individual was \$996. The bituminous coal industry employed 1,925 people with an annual payroll of \$24,417,948 and for an average monthly wage per person of \$1,057. The balance of people working in the mining industry of Utah were in the nonmetallic, petroleum refining and related industries, and quarries.

Figures reported through the end of November 1975 show 13,000 persons employed in the mining industry: 7,300 in metal mining, 2,500 in bituminous coal mining, and 3,200 in other mining jobs and in quarry plants.

⁵Source: Volume III, *Labor Market Information*, the Department of Employment Security of the Industrial Commission of Utah, Annual Report, August, 1975. Department of Employment Security, *Employment Newsletter*, November 1975.

Table 3. Payments to Utah from federal land revenues.

Year	Public land and material sales	Mineral leases	Taylor grazing districts	Other	Total
1921-1950	\$187,300	\$ 2,354,749	\$ 119,692		\$ 2,661,741
1951-1955	14,725	5,328,663	133,256		5,476,644
1956-1960	16,994	10,807,930	149,869		10,974,793
1961-1965	15,390	19,890,050	166,514	\$ 500	20,072,454
1966	2,709	3,622,874	36,194		3,661,777
1967	1,573	3,160,478	37,163	110	3,199,324
1968	970	3,001,920	34,632		3,037,522
1969	1,018	3,238,526	37,622	1,485	3,278,651
1970	5,961	3,247,863	47,489	1,171	3,302,484
1971	2,236	3,477,509	54,759	1,644	3,536,148
1972	3,426	3,762,034	59,969	2,941	3,828,370
1973	2,551	4,272,391	61,735	1,400	4,338,077
1974	1,072	5,008,557	74,614	1,333	5,085,576
1975	147,305	5,306,947	65,794	1,803	5,521,849
Total	\$403,230	\$76,480,491	\$1,079,302	\$12,387	\$77,975,410

Source: U. S. Bureau of Land Management, *BLM Facts & Figures for Utah-1975*.

MINERAL PROPERTY VALUATION⁶

The 1975 tax assessments, occupation taxes, and valuations on mineral properties show large increases. The assessed valuation for the 1975 tax year (based on 1974 production) was \$298,608,721 compared with \$286,741,397 for 1974. However, the 1974 assessment is below that in 1973 of \$301,941,184. Mine occupation tax assessed in the 1975 tax year was \$8,418,526 on 23 mining properties and on 75 oil and gas properties. The largest occupation taxes (severance tax) of

\$5,448,282 were assessed on oil and gas properties. Copper mines follow with \$2,791,942.

Oil and gas property valuation more than doubled during 1974 from \$84,220,173 to a new record high of \$194,443,301. Oil and gas pipeline assessment was also up, totalling \$14,451,923 as compared with \$13,451,717 in 1973.

The increase in oil and gas property valuation for 1974 is due largely to increased prices paid for oil, which ranged from \$3.40 to \$5.80 per barrel in 1973 to \$8.10 to \$9.70 per barrel in 1974. Nevertheless, oil and gas production in Utah was up, and more than 39,363,032 barrels of oil were produced

in 1974 compared with 32,544,000 barrels in 1973. About three-fourths of the total tax bill was paid by operators of the Greater Altamont-Bluebell oil field of Duchesne and Uintah Counties; this payment was \$3,729,003, 70 percent of the \$5.4 million in taxes paid.

NOTES ON TREATMENT OF STATISTICS

UGMS has discontinued compiling production statistics on commodities by county. The large amount of information withheld as confidential has made such compilations largely incomplete and meaningless. Production statistics for the state as a whole are compiled in table 1.

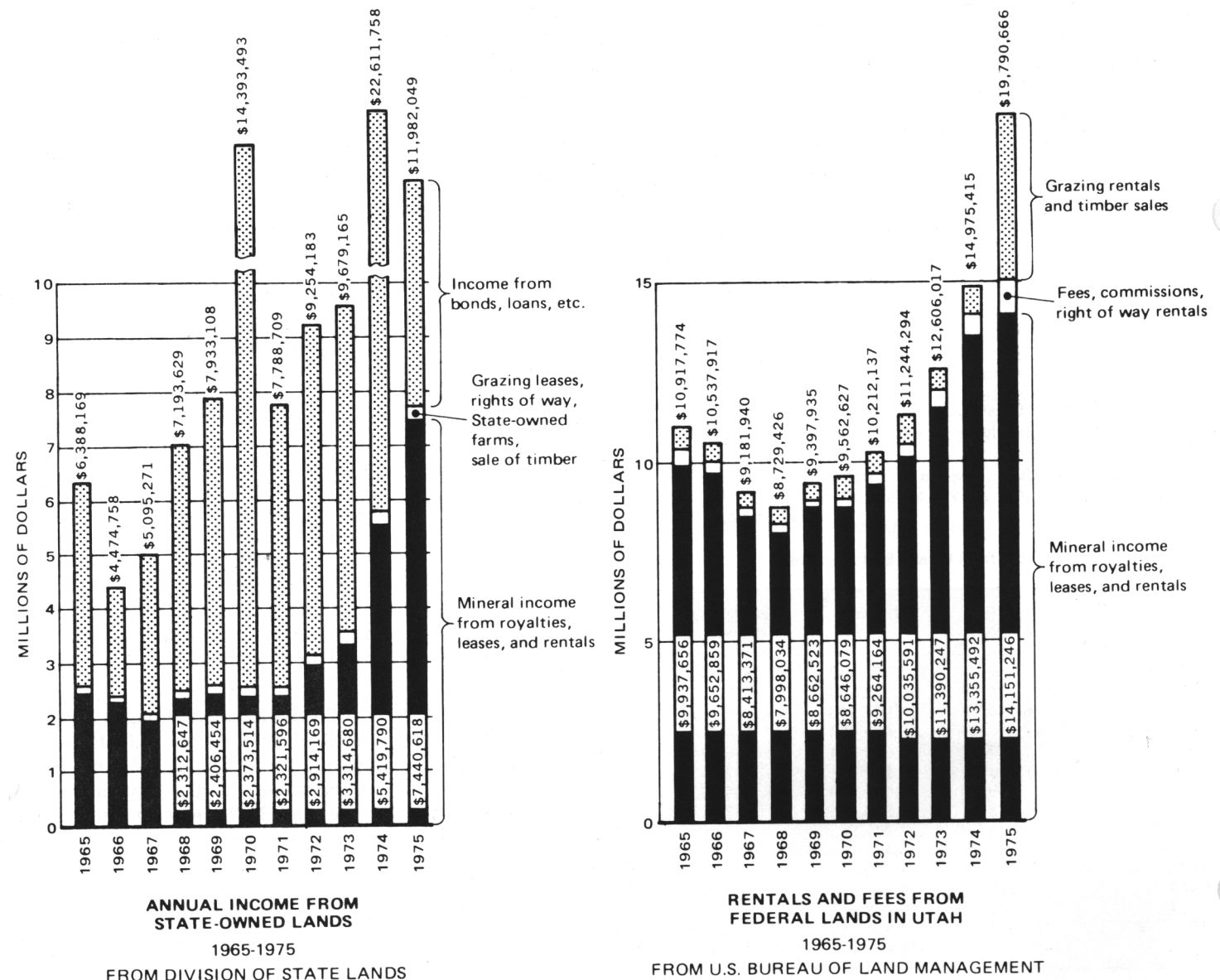


Figure 3. Source of income from Utah lands 1965-1975.

Production statistics and an activity review for 1973-74 were published as UGMS Circular 57 (July 1975).

Federal and state mineral statistics relating to leasing and royalties are kept by fiscal year (July 1, 1974 to June 30, 1975). U. S. Bureau of Mines statistics are kept by calendar year.

UTAH MINERAL OPERATIONS

Alunite

National Steel Corporation, Southwire Company, and Earth Sciences plan a \$360 million project to produce alumina, potassium sulfate, and sulfuric acid from alunite deposits in southwestern Beaver County. The acid will be used in the production of triple superphosphate from Idaho phosphate ores. Conversion facilities are being planned in an area of the Wah Wah Valley, 30 miles southwest of Milford, Utah. The companies plan to produce 500,000 tons of alumina, 240,000 tons of potash sulfate, and 550,000 tons of triple superphosphate annually. National Steel and Southwire each have a 40 percent interest in the project, and Earth Sciences 20 percent. During 1975, about 5,000 tons of ore were shipped to the Golden, Colorado, pilot plant from Earth Sciences' Utah properties. Coal from the Price area will fuel the 70-megawatt power plant to be built at the Utah site.

In late 1975, the U. S. Bureau of Land Management began preparing an environmental impact statement. Earth Sciences previously submitted its plan for mining and operation of the proposed processing plant. Meteorological studies assessing impacts on air quality are also under way.

Barite

Five Salt Lake City companies—Custom Milling and Supply Company, Circle Mines Incorporated (a subsidiary of Eisenman Chemical Company), Rocky Mountain Refractories, Westemco Incorporated, and All Minerals Corporation—process crude barite, which is mined in California and Nevada, into well drilling mud, valued at more than \$2 million yearly. Unofficial reports indicate nearly 70,000 tons of barite is processed by the Utah operators each year.

Beryllium

Bertrandite ores at Brush Wellman Incorporated's Delta plant are processed into beryllium hydroxide. Assessments on the Topaz area facilities during 1975 were more than \$1.8 million. Production figures are withheld by the company. Beryllium is used as a metal in nuclear reactors and aerospace applications and as an alloy in electrical equipment and electronic components.

Brick

U. S. Steel Corporation is expanding its Keigley quarry rock dust facilities at the south end of Utah Lake near Payson, Utah. A new mill is being constructed to produce rock dust required by the growing coal mine industry in Utah and other western states. The Keigley dolomite, a high quality product because of its extremely low silica content, is pulverized into rock dust that is to be used in underground coal mines to prevent coal dust explosions. The rock dust is sprayed on mine surfaces, making the coal dust noncombustible.

Interpace (International Pipe and Ceramics Corporation) is producing 11.5 million bricks a year for Utah contractors and sells another 2.5 million made by company plants elsewhere in the United States. The Harrisville plant in Weber County manufactures clay facebrick for residential and commercial construction. Clays are hauled by trucks from various locations in Utah, which include Pleasant View, Lehi, and Sevier County, to the plant. The plant employs 41 persons at an annual payroll of \$415,700. A new kiln, besides new office and showroom facilities, is being constructed.

Clay and Shale

Eleven companies with 17 locations process raw clay and shale in seven counties in Utah. The clay and shale industry in the state produces more than 235,000 tons each year valued at \$953,000. Kaolin, fire clay, azomite, bentonite, and fuller's earth are also produced.

Preliminary reports of the U. S. Bureau of Mines show that clay production in Utah in 1975 was 239,000 tons. In 1974, 3,153 tons of bentonite, 2,174 tons of fuller's earth, and 201,201 tons of common clay and shale were valued at

\$952,946. Bentonite was valued at \$49,172. No figures were released for fire clay during 1974, but 1973 production of 5,300 tons was valued at \$32,000. Fuller's earth produced in 1974 was 2,174 tons valued at \$46,000.

Coal

The highlight of 1975 activity was an announcement by Braztah Corporation, subsidiary of McCulloch Oil Company, of its purchase of North American Coal Company's Kenilworth property at Castlegate and the Carbon Fuel mine in Hardscrabble Canyon to produce unit-train loads of coal for delivery to American Electric Power Company plants in the midwest. Braztah is committed to produce 140 million tons for American Electric Power over the next 25 years. The annual rate of production for this project is expected to peak at 6.5 million tons by 1982. Braztah also announced that a contract was signed with Indiana and Michigan Electric Company to develop and operate coal mines in Carbon County with the Indiana and Michigan Electric Company supplying funds for production. Most of the coal will be consumed in power plants operated by the Indiana and Michigan Electric Company. Braztah expects to employ more than 1,500 miners within the next six years.

U. S. Steel and Kaiser Steel are expected to continue producing coking coal from the Book Cliffs field in eastern Carbon County for their steelmaking plants at Orem, Utah and Fontana, California.

Swisher Coal Company, a major coal producer, was acquired by General Exploration Company of Dallas. The properties produce 250,000 tons of coal annually, and General Exploration plans to double that rate within a year. General Exploration has signed a \$13 million contract to supply steam coal to a large industrial firm in Chicago.

Four mines operating north of Huntington Canyon in the Wasatch Plateau region have a combined annual tonnage in excess of 1.2 million. Two mines on the south side of Huntington Canyon supplied most of Utah Power and Light Company's needs in Utah during the year. In 1974, the utility completed and started its first 430-megawatt Huntington Canyon plant, and it started con-

struction on another to be completed in 1977. Two additional units are planned at another site in Emery County.

Coastal States Energy doubled its Convulsion Canyon mine production from 300,000 to 700,000 tons for its industrial and commercial markets.

During 1975, Inspiration Consolidated Copper Company reported completion of development drilling at its Ferron Canyon, Sanpete County, coal properties and submitted tentative mine development plans to the U. S. Bureau of Land Management for approval. The company estimates a reserve of 18 million tons of low-sulfur bituminous coal on the properties.

Plans of Kaiser Industries Corporation and three other firms to develop coal-mining facilities to fuel the Kaiparowits power plant have been cancelled after plans for the project were dropped.

A \$5.5 million modernization and improvement program is under way by Kaiser Steel Corporation at its Sunnyside mines. The project is designed to extend the life of the mines by 25 years or more at current production levels. The Sunnyside mines cover an area of five square miles and increase at a rate of 140 acres a year.

Pacific Gas and Electric Company conducted drilling operations in the Roan Cliffs area near Price during the year. The company hopes to develop at least 150 million tons of underground coal. Purchase of properties from Island Creek Coal Company was conditionally agreed to, providing that exploration confirms existence of the coal reserve.

The United States Fuel Company is expanding its facilities to increase coal output from 750,000 to 800,000 tons per year. Nearly \$2 million is designated for new truck loading facilities at the Middle Fork property in Carbon County.

Nevada Electric Company's Warner Valley power plant near St. George and south of Hurricane will obtain its coal from the Alton field. The Salt Wash area of Wayne County is the site of a 3-million kilowatt electric-power generating plant planned by the Intermountain Power Project. The site is approximately 10 miles north of the town of Caineville. Work is under way to obtain information

for the environmental impact statement. The \$1.5 billion project will occupy about 2 square miles and is planned for operation in 1981. Participants are the Intermountain Consumer Power Association of Sandy, Utah, and the California cities of Anaheim, Burbank, Glendale, Los Angeles, Pasadena, and Riverside.

Seven core holes and some surface work were completed in 1975 by the Utah Geological and Mineral Survey and the U. S. Geological Survey in the Wasatch Plateau region, Sanpete and Emery Counties.

Copper, Gold,
Lead, Silver, and Zinc

Nine operating mines in Utah are in eight counties: Beaver, Garfield, Juab, Salt Lake, San Juan, Summit, Uintah, and Utah. The largest is Kennecott Copper Corporation's open pit mine at Bingham, Salt Lake County, which is also the largest copper-producing mine in the United States. Copper production in 1975 fell below that of 1974. The price of copper per pound dropped from a 1974 average of \$.77 to \$.63 in 1975. Lead-zinc operations in Utah produced more than 30,000 tons of ore worth more than \$19 million in 1975. Lead production gained over the 1974 rate. Lead prices stayed consistent in 1975 around the \$.20 per pound rate but were down compared to the 1974 average price of \$.22½. Zinc production gained over 1974. The price of zinc ranged between \$.35 and \$.38 per pound in 1975.

Damage was estimated at near \$500,000 at the Essex International mill near Milford from a fire in August 1975 that destroyed several storage tanks, which were owned by Toledo Mines and under lease to Shield Development Company. Essex International, which produced copper, gold, and silver from its properties in 1974, discontinued operations in 1975.

Work was cut back in two of the four shafts under construction at Anaconda Company's Carr Fork mine in the Bingham district in August. The company, however, will still meet its deadlines for production during 1979, but only 5,000 tons of ore will be mined daily when production begins, half of that originally planned.

Work was started in late 1974 by Kennecott Copper Corporation on a smelter emission control program costing \$175 million. Major elements of the program include extensive modification of the process gas handling equipment designed to capture pollutants, changes in the furnace area, additional sulfur collection facilities, and a computerized emission monitoring system to aid in controlling the level of smelter production. A 1,200 foot stack at the site was constructed at a cost of about \$9 million. Late in 1975, the Environmental Protection Agency set new SO₂ emission standards for Kennecott. The EPA regulations, which will now necessitate construction of a double-contact acid plant, require Kennecott to remove 94 percent to 95 percent of the SO₂. Kennecott's renovation plans had called for a single-contact acid plant and facilities for an early projection of costs approaching \$40 million.

Park City Venture's new 750-ton flotation concentrator in the Park City district started processing lead-zinc-silver ores from the old Ontario No. 3 shaft during April. The company, mining at the rate of 700 tons daily, indicates that the ore contains an average of 9 percent lead, 11 percent zinc, and 5 ounces of silver per ton. The company employs 225 people.

New Park Corporation of New Orleans announced that a joint venture called the Consolidated Mayflower Mines Incorporated was formed for holding mineral rights at its Mayflower mine and in areas near Park City. It consolidated rights to the Mayflower vein below 200 feet and sold the surface rights to Ion Investment Company in 1972. New Park also announced acquisition of 25 acres of land adjacent to the Mayflower portal for \$50,000. Ion has a 20 percent interest in the venture. The Mayflower mine was originally owned and operated by the New Park Mining Company and later leased by Hecla Mining Company, which discontinued operations three years ago.

Fluorspar

Three mines produce fluorspar in the Topaz Mountain area of Juab County. Metallurgical grade fluorspar, used as a flux in the steel industry, is produced by Wildden Fluorspar Company at its Lost Sheep Incline mine, by U. S. Energy Corporation at the Fluorine Queen mine,

and by Spor Brothers Mining at the Fluoride mine. All three mines are about 30 miles northwest of Delta.

Geothermal Resources

Utah's first successful geothermal well, was completed by Phillips Petroleum in the Roosevelt Hot Springs area of Beaver County. It flowed with more than 200,000 pounds of wet steam per hour at a temperature over 400°F. The well, drilled by Loffland Brothers Drilling, bottomed at 2,728 feet. It is the second well to be drilled on the Roosevelt Known Geothermal Resource Area (KGRA) and is on a 2,453 acre lease tract that Phillips obtained for a bonus bid of \$314,199 at the Roosevelt KGRA lease sale held by the U.S. Bureau of Land Management in 1974. Phillips successfully bid on 9 other tracts in the area and was subsequently awarded 10 leases that total 18,912 acres. Total bids on the Roosevelt Hot Springs sale amounted to \$877,189. Another sale at the Cove Fort-Sulphurdale geothermal area brought a total bid of \$3,676,123.

Several areas in western Utah, in addition to Roosevelt Hot Springs, have received KGRA designation: Lund, Thermo Hot Springs, Cove Fort, Monroe, Abraham Hot Springs, and the Navajo Lake vicinity. Several other localities, Bonneville Salt Flats, Brigham City area, Eureka vicinity, and the area west of Topaz Mountain, were explored in 1975.

Gilsonite

No production figures for 1975 have been reported by the U.S. Bureau of Mines. However, several gilsonite operations are being conducted in Utah. The Utah Geological and Mineral Survey reported in 1974 that the Bonanza plant produced 370,000 tons; annual production of electrode-grade coke was 90,000 tons; gasoline was 23,000,000 gallons; and road oils and industrial fuels were 6,000,000 gallons.⁷ Gilsonite, worth \$70 to \$100 a ton, is now used by the Boise Cascade Corporation as a binder in its particle board. Other uses include it as a body sealer on automobiles, road mix component, floor tile colorant, coating for pipe, a component of paints, inks, and

storage batteries, and in electrode-grade coke manufacture. The Bonanza mill and plant is operated by the American Gilsonite Company. More than 60 people are employed at the facility.

Synthetic Graphite

A small amount of synthetic graphite fibers was produced at the Geneva complex in Utah County by Hercules Incorporated.

Gypsum

Five plants produce more than 290,000 tons of gypsum each year. Major production by U.S. Gypsum Company and Georgia-Pacific Corporation is at two plants at Sigurd, Sevier County. Two open pits in this area have reserves of high-quality gypsum rock estimated at about 12 million tons. Cox Enterprises Incorporated has a plant at Levan. White Mountain Gypsum Company is at Fillmore, and Thomas J. Peck and Sons Incorporated is at Nephi.

Iron Ore

Two mining districts, the Pinto and Iron Springs, west of Cedar City in southwestern Iron County, are the largest iron-producing districts in the western states. Six companies are operating in the Pinto district and four in the Iron Springs district. The largest producing operations are conducted by Utah International Incorporated in the Iron Springs area and include the Excelsior, Smith and Pittsburgh, Adams, Walker and Armstrong, Black Iron, Wilson, Iron Apex, Thompson, and other pits. Last year, approximately 1,300,000 tons of ore were produced from the Iron Springs district. The Colorado Fuel & Iron Company's Blowout mine, Duncan mine, McCahill-Thompson properties, and the Comstock mine also are major producers. United States Steel Corporation's Mountain Lion mine in the Pinto district and the Duluth & Utah Iron Mining Company are active.

Lime

In 1974 Tooele County accounted for more than 136,000 (77 percent) of the 176,319 tons of lime produced in the state. Largest operations in Tooele County are those of the Flintkote Company, U.S. Lime Division's two shaft-kiln plant in the Free Coinage

mining district near Dolomite, and Utah Marblehead Lime Company's rotary-kiln plant in the Lakeside mining district near Delle. In Box Elder County, the Utah-Idaho Sugar Company has a lime plant at Garland. Mountain States Lime Company's Provo plant is in Utah County. Lime is also produced by the Kennecott Copper Corporation at its Salt Lake County operations.

Magnesium and Magnesium Components

Great Salt Lake Minerals and Chemicals Corporation extracts sodium chloride (salt), sodium sulfate, magnesium compounds, and potassium salts from Great Salt Lake brines at its Ogden plant and facilities in Weber County. In Tooele County, Kaiser Aluminum and Chemical Corporation's processing plant produces magnesium chloride compounds from brines pumped from beneath the Bonneville Salt Flats east of Wendover. National Lead Industries' Rowley plant in the Lakeside mining district is a producer of magnesium compounds and chlorine and potassium salts. In late September 1975, National Lead announced that 250 employees of its 600-man force would be laid off because of failure to meet planned production goals. The company originally had planned to produce 45,000 tons of magnesium per year, but it only reached 14,000 tons or 30 percent of rated capacity. The failure is due to mechanical problems. The company has contracted with Norsk Hydro, a Norwegian magnesium producer, to study the project and recommend modifications.

Molybdenum

Molybdenum ore and concentrate is produced by Kennecott Copper Corporation in Salt Lake County as a by-product of concentration of copper ores mined at the Bingham Canyon mine. Production figures are held confidential by the company. Molybdenum is used for electrodes in mercury-vapor lamps, as wire for winding electric-resistance furnaces, and in steel alloys.

Perlite

Expanded perlite, used as a plaster aggregate, is produced in Sevier County by the Georgia-Pacific Corporation at its Sigurd plant. Production figures are withheld by the company.

⁷Source: Bulletin 105, Utah Geological and Mineral Survey, *Utah's Mineral Activity: An Operational and Economic Review*, October 1974, by C. H. Stowe.

Table 4. Minerals activity on federal lands in Utah—July 1, 1974 to June 30, 1975.¹

Commodity	Mineral permits and licenses		Cumulative mineral leases outstanding		Production	1974 receipts ²	
	Number	Acres	Number	Acres		Leases, permits	Royalties
Oil and gas	2,833	3,246,254	15,152	14,420,484	8,056,459 bbls	\$12,115,410	\$5,490,538
Competitive oil and gas	20	7,683	—	—	—	—	—
Natural gas	—	—	—	—	30,134,520 TCF	—	—
Oil and gas liquids	—	—	—	—	27,054,475 gals.	—	—
Coal	0	0	242	402,362	3,516,543 s.t.	1,186,239	820,283
Other	—	—	—	—	12,080 s.t.	23,697	23,279
Potash	0	0	40	60,199	89,372 s.t.	47,801	41,681
Phosphate	0	0	13	20,138	72,180 s.t.	31,218	31,218
Gilsonite and bituminous sands	0	0	12	3,210	—	—	—
Carbon dioxide	—	—	—	—	100,739 TCF	—	—
Silica sand	—	—	—	—	—	—	—
Hardrock	0	0	3	420	—	—	—
Geothermal	61	105,136	61	105,136	—	—	—
Total	2,914	3,359,073	15,523	15,011,949	—	\$13,404,365	\$6,406,999
(7-1-73 to 6-30-74)	1,771	2,557,260	15,461	14,909,355	—	\$11,398,517	\$5,266,270

Source: U. S. Bureau of Land Management: *BLM Facts & Figures for Utah—1975*, and *Public Land Statistics—1974*, tables 111 and 112.

¹ Total receipts from leases and permits on public lands in fiscal year 1975 include royalties on federal leases collected by the U. S. Geological Survey: \$19,790,666.

² Allocation of U. S. Bureau of Land Management receipts to Utah for mineral leases and permits: \$5,521,849. TCF = thousand cubic feet, CF = cubic feet, s.t. = short tons, bbls = barrels (42 gallons), gals. = gallons.

Phosphate

Production and value of Utah's phosphate ore are withheld by the U. S. Bureau of Mines at the request of the producers. Production in 1975 reported by the U. S. Bureau of Land Management amounted to 72,180 tons (table 4). Federal land under phosphate leases totaled 20,138 acres.

During 1975, nine phosphate operations in the state were under way, five in Rich County and four in Uintah County. The largest phosphate operation is in the Crawford Mountains, Laketown and Woodruff Creek areas of Rich County. Stauffer Chemical Company's Leefe, Wyoming, beneficiating plant processes ore from the Rex Peak-Brazier Canyon area properties east of Randolph. The concentrate is shipped by railroad to the Garfield plant in Salt Lake County. Other Rich County properties are held by Alger Chaney—Trustee, Bradley Estates Incorporated, Sutter Mining and Development, and Food Machinery Chemical Corporation. Stauffer Chemical also operates phosphate properties north of Vernal, Uintah County. During 1974, the company expanded its operations by 40 percent both in the city and at its beneficiating facility. Humphreys Engineering Company and A. R. Kidd also have phosphate properties in Uintah County.

Potash

Texasgulf Incorporated achieved record potash production at their Cane Creek facility west of Moab during September 1975. The company announced that a record 80,000 tons of solar-evaporated salt, which averaged about 21 percent K₂O, were harvested during the month and that the plant turned out over 23,000 tons of high quality potash. In 1974, Texasgulf produced 261,000 tons of potash at their solar evaporation ponds. Throughout 1975, experimental work was conducted to increase solar evaporation by use of sprays and dyes. Texasgulf has acquired other properties in southeastern Utah, principally at the Seven Mile area, where potash deposits are known to exist.

Kaiser Aluminum and Chemical Corporation processes potassium salts in Tooele County. The Great Salt Lake Minerals and Chemicals Corporation processes potassium salts in Weber County.

Pumice (Volcanic Ash)

Pumice was produced in Iron and Millard Counties. Quarries in the Summit area of Iron County and in the Fillmore area of Millard County were operated by the Utah State Department of Highways.

Salt

Salt production, valued at more than \$7 million, climbed past 775,000 tons in 1975. Eight operators are active in the state. Six counties have salt production with one operation each in Box Elder, Salt Lake, Sanpete, Sevier, and Weber. Tooele County's three operations, American Salt Company, Hardy Salt Company, and the Utah Salt Company, produce nearly half of the total production in the state.

Sand and Gravel

Sand and gravel is one of Utah's largest industries. In Utah's early history, sand and gravel were simply dug from river bottoms and hillsides as the occasion warranted. It was not until 1908 that commercial operations began. That year approximately 21,000 tons were quarried. The industry continued to grow, and in 1923 a million tons were quarried for the first time. The million ton-per-year figure was maintained for the next 13 years. Then, in 1936, two million tons were reached; in 1942, three million tons; and in 1953, four million tons. In 1956, Dr. ElRoy Nelson*

*Source: *Utah's Economic Patterns*, Dr. ElRoy Nelson, University of Utah Press, Salt Lake City, Utah, 1956.

reported that 22 sand and gravel quarries of relatively large size in Utah employed about 100 people and had an annual payroll of \$330,000. Today, almost 20 years later, employment is more than 250 people with an annual payroll in excess of \$1.7 million.

During the past 10 years nearly 114 million tons of sand and gravel, valued at slightly more than \$125 million, were quarried. In 1974, 72 commercial operations in the state produced 11,578,000 tons of sand and gravel. In 1975, 11,463,000 tons valued at \$17,194,000 were produced. More than half of Utah's total production comes from Salt Lake, Davis, and Utah Counties where 34 operators are active. Eighteen companies in the state produce 200,000 tons each per year, while another 18 produce less than 25,000 tons each. Four companies produce annually more than one million tons each. Five companies produce an average of 18.3 percent of the total production: each between 400,000 and 500,000 tons yearly.

Today, most sand and gravel is screened and sold on the basis of size and quality. Special types of sand are used in glass making, in sand molds, as grinding materials, in fluxes, and in filters. Sand and gravel are widely used in the construction industry because they provide strength, durability, and bulk at comparatively low unit prices; and because they are abundant, universally used, and relatively low priced, their mineral resource value has not always been fully appreciated.

Most unprocessed (raw) sand and gravel is used as commercial fill.⁹ Some 3,736,000 tons, which were valued at slightly more than \$2,254,000, were used this way in 1974. Concrete aggregate (including use in ready-mixed concrete) used 2,451,000 tons, valued at \$4,600,000, for commercial road base. Slightly more than 2,262,000 tons, valued at \$2,743,000, were used in both residential and nonresidential construction. Other uses for sand and gravel are in highway and bridge construction, dams, waterworks, airport construction, concrete blocks, bricks, pipe, and asphalt and tar paving.

Fifty-nine surface pit operations in 1974 produced 7,819,000 tons of sand

⁹ Source: *Mineral Industry Surveys*, U. S. Bureau of Mines, November 1975.

and gravel valued at \$8,986,000. Dredging operations were conducted in three pits, dragline work in three pits, and shovel operations in two pits. Forty-five operations were conducted with a front-end loader. Six operations used other methods of processing. Capital investment for 1974 in Utah's sand and gravel industry was estimated just over \$12,640,000.

Most Utah operating companies produce sand and gravel from their own properties. During 1974, 37 operators produced 6,460,000 tons from their own land; 16 companies leased private land, and the rest either owned or leased mineral rights or leased public land.

Utah sand and gravel reserves are estimated at 141,503,000 tons in dry surface pits, and 4,215,000 tons in wet sand and gravel deposits. Reserves in navigable and non-navigable river beds and lakes are not calculated.

The market for sand and gravel has continued to expand in Utah, and growth is expected to continue particularly in developing urban areas.

Sodium Sulfate

The principal sodium sulfate producer in Utah is Great Salt Lake Minerals and Chemicals Corporation. Salt cake (Glauber's salt) is produced at the Ogden plant in Weber County.

Sulfur

The Chevron Oil Company produces by-product sulfur in excess of 1,100 tons yearly at its Salt Lake County refinery. Value is more than \$35,000.

Stone

Stone is produced in 12 counties. Three counties, Box Elder, Morgan, and Utah, usually account for 60 percent of Utah's total output of just under three million tons. Five quarries produce primarily dimension stone, and 22 quarries produce crushed and broken stone.

Tungsten Ore and Concentrate

Tungsten ore was mined from the Blair Sorenson mine in the Newfoundland Range in Box Elder County and at the

Timms Tungsten Company's Fraction Lode mine near Wendover in Tooele County. The C & P Leasing Company also produced tungsten at its Star Dust mine in the Gold Hill area in Tooele County. Production data has been withheld by the companies.

Uranium

Utah's uranium industry ranks third in the nation, exceeded only by Wyoming and New Mexico. Although figures have been withheld by the U. S. Bureau of Mines since 1973, ore production has increased since 1967. During that year Utah operators produced 254,538 tons.¹⁰ Production at the close of 1972 was 470,513 tons. It is estimated that 1975 production exceeded 500,000 tons.

Utah has 30 mines producing nearly 2 million pounds of uranium oxide that is valued in excess of \$20 million a year. Mines are in Emery, Garfield, Grand, and San Juan Counties, with San Juan County being the principal uranium producer.

Construction of a new circuit for processing uranium-vanadium ores at Atlas Minerals' Moab mill is expected to be completed by early 1976. An additional 30 jobs will become available when the system is in operation. Atlas announced late in 1975 that it had signed a two-year agreement to supply Houston Lighting and Power Company with 1.25 million pounds of uranium concentrate. Depending upon market prices, uranium value of the Houston Lighting and Atlas arrangement could approach \$35 million. Atlas has further made agreements with Phillipp Brothers, a division of Engelhard Minerals and Chemical Corporation of New York, for the purchase of all vanadium produced by the Moab mill through 1980. It is expected that about 15 million pounds, valued at \$30 million, will be produced during that period.

Atlas Minerals' uranium mill at Moab now employs 230 workers, which includes 61 constructions workers whose work is to be completed by spring of 1976.

Utah Power and Light Company is investigating ore potential of some 300

¹⁰ Source: Utah Geological and Mineral Survey, Bulletin 106, *Utah Mineral Industry Statistics through 1973*, by Carlton H. Stowe, April 1975.

claims in the Black Action group and Lark-Royal properties in San Juan County. If exploration shows promise, the properties will be developed in cooperation with the current operator, Mineral Energy Incorporated.

Rio Algom Ltd. of Canada has tentatively agreed to sell Washington Public Power Supply Systems of Richland, Washington, one million pounds of uranium oxide in concentrates. The agreement is under consideration by the Canadian government. The uranium firm's U. S. subsidiary, Rio Algom Corporation, operates the La Sal-Lisbon mine and concentrator southeast of Moab.

Ranchers Exploration and Development Corporation of Albuquerque announced during the year that an extensive drilling program in Utah and New Mexico disclosed additional uranium reserves that contain approximately 1.3 million pounds of U_3O_8 . The largest part of the new reserves, approximately 800,000 pounds of uranium oxide, is in the Small Fry mine in the Big Indian district near Moab. The operator expects to begin mining operations with plans calling for a production rate of 250 tons of ore per day.

Vermiculite

Vermiculite International Incorporated of Salt Lake City is one of 54 exfoliating plants in 31 states that processes vermiculite. The U. S. Bureau of Mines reports that only one company is producing vermiculite and that two mines in Montana and South Carolina produce virtually the entire output. Vermiculite products from Utah are used in concrete, in plaster and roofing aggregate, as loose fill insulation, as pipe-covering insulation, as a soil conditioner, and in other miscellaneous uses.

OIL AND GAS ACTIVITY 1975

Oil and gas operators drilled 198 wells in Utah during 1975, one more than in 1974, and more than in any year since 1963 when 214 wells were drilled. However, overall drilling in Utah was behind that of the Rocky Mountain states where well completions increased 29.5 percent, from 3,547 to 4,595 wells—the highest total since 1959 (table 5).

Table 5. Summary of results of oil and gas drilling in Utah, 1975.

	Oil	Gas	Dry	Total	Footage	Percent total completions	Percent total footage	Average depth	Success ratio (percent)
New field wildcats	5	1	51	57	400,893	4.04	5.00	7,003	10.53
New pool and wildcat outposts	3	4	1	8	79,869	2.45	4.31	9,984	87.50
Development wells	106	15	12	133	1,192,256	4.65	7.76	8,964	90.98
Total—all wells	114	20	64	198	1,673,018	4.31	6.62	8,450	67.68

Discoveries in Utah

The only significant discovery of oil in Utah in 1975 was the No. 1 Newton Sheep Company well drilled by American Quasar Petroleum, Energetics, Inc., and North Central Oil in NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 4, T. 2 N., R. 7 E., Summit County. This well was completed flowing 533 barrels of oil and 250 mcf gas per day from perforations at 9,928 to 9,936 feet in the Jurassic Nugget Sandstone. Total depth was 14,500 feet. This well opened the Pineview oil field, the first oil and gas production in the geologically complex overthrust belt of northern Utah.

The field was confirmed and extended by two additional wells and the discovery of a second pay zone, the Jurassic Twin Creek Limestone above the Nugget. At the end of 1975 the Pineview field had produced 225,000 barrels of oil, and production was averaging 1,100 barrels per day.

This discovery and another in adjacent Uinta County, Wyoming, triggered extensive leasing, geophysical and new drilling in northern Utah and in adjacent areas of southeast Idaho and southwest Wyoming.

Other discoveries in Utah were a small gas discovery by Mountain Fuel Supply in San Juan County and two small oil and gas discoveries by Shell Oil and another by Chevron in the area east of the Greater Altamont-Bluebell oil field, Uintah County. A small gas and oil discovery was also completed by Pacific Transmission Supply in the Chapita Wells area of eastern Uintah County.

A well drilled by Northwest Pipeline extended Dakota Sandstone production in the Clay Basin gas field, Daggett County, to the west. Two other test wells proposed to extend the field were not drilled.

Atlantic Richfield extended Dakota and Cedar Mountain gas production in the East Canyon Field, Grand County. Chevron Oil and Flying Diamond Corporation extended two oil producing areas in the East Gusher area, Uintah County, and Texaco continued extension of the Seep Ridge gas field in southern Uintah County.

Phillips Petroleum abandoned No. 1 U. S.-E. NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 27, T. 19 S., R. 3 E., Sanpete County, Utah's deepest well. The well, about 12 miles southeast of Manti, was drilled to 20,540 feet.

Oil and Gas Production

Production of oil and natural gas increased in Utah from 1974 to 1975. In 1975 production of oil was 40,025,353 barrels as determined by the Utah Division of Oil, Gas and Mining and 39,854,000 barrels as determined by the U. S. Bureau of Mines (table 1).

Production of natural gas was 58.888 billion cubic feet according to the U. S. Bureau of Mines and 76.183 billion cubic feet according to the Utah Division of Oil, Gas and Mining. The Bureau of Mines figure tends to reflect marketed production of natural gas; the State figures include all gas produced regardless of use or disposition.

A breakdown of the production statistics of the Utah Division of Oil, Gas and Mining reveals the importance of Utah's large fields (tables 6 and 7). The three giant fields—Greater Altamont-Bluebell, Greater Aneth and Greater Red Wash—account for 88.5 percent of 1975 oil production and 79.4 percent of Utah's cumulative production. Production from Greater Altamont-Bluebell averaged 63,500 barrels per day and accounted for 57.9 percent of Utah's 1975 production.

Table 6. Utah's seven largest oil fields (ranked in order of 1975 production).

	Production 1975 (bbls)	Average bbls per day 1975	Percent state total 1975	Cumulative production thru 1975 (bbls)	Percent state cumulative total
Greater Altamont-Bluebell Duchesne and Uintah Cos.	23,189,416	63,533	57.9	72,150,203	13.1
Greater Aneth San Juan Co.	8,324,616	22,807	20.8	268,526,007	48.6
Greater Red Wash Uintah Co.	3,940,854	10,797	9.8	97,904,544	17.7
Upper Valley Garfield Co.	1,479,960	4,055	3.7	14,789,908	2.7
Lisbon San Juan Co.	1,074,850	2,945	2.7	38,637,769	7.0
Bridger Lake Summit Co.	534,476	1,464	1.3	8,634,295	1.6
Ashley Valley Uintah Co.	217,752	597	0.6	17,860,818	3.2
Total of other fields (for 1975) (for all time cumulative)	1,263,429	3,461	3.2	33,556,110	6.0
GRAND TOTAL	40,025,353	109,659	100.0	552,059,654	100.0

Table 7. Utah's seven largest gas fields (ranked in order of 1975 production).

	Production 1975 (mcf)	Percent state total 1975	Cumulative production thru 1975 (mcf)	Percent state cumulative total
Greater Altamont-Bluebell Duchesne and Uintah Cos.	27,117,697	35.6	75,246,618	5.2
Lisbon San Juan Co.	16,493,206	21.6	266,159,908	18.5
Greater Red Wash Uintah Co.	6,812,569	8.9	279,792,564	19.4
Greater Aneth San Juan Co.	6,395,958	8.4	261,397,898	18.1
Bridger Lake Summit Co.	3,191,250	4.2	15,101,933	—
Clay Basin Daggett Co.	2,946,427	3.9	129,587,305	9.0
San Arroyo Grand Co.	2,491,606	3.3	61,731,787	4.3
Clear Creek ¹ Emery Co.	266,090	—	135,306,966	9.4
TOTAL	65,448,713 ²	86.0	1,209,223,046 ³	83.4
TOTAL OF OTHER FIELDS	10,734,628	14.0	232,159,352	16.1
GRAND TOTAL	76,183,341	100.0	1,411,382,398	100.0

¹ Clear Creek gas field is now largely used for storage. It is included in this listing because it ranks among the first seven fields in all time cumulative production.

² Does not include Clear Creek.

³ Does not include Bridger Lake.

High production rates at Greater Aneth are being sustained by an active water flood (secondary recovery) and by aggressive drilling of new wells within the outlines of the field (in-fill drilling).

Utah's seven largest oil fields produced 96.8 percent of the 1975 total and have produced 94.0 percent of the cumulative total. The seven largest gas fields produced 86.0 percent of the 1975 total and have produced 83.9 percent of the cumulative total. Other important gas fields include: Big Indian, San Juan County; Natural Buttes, Uintah County; and Westwater, Grand County.

Natural Gas Processing Operations

Seven natural gas plants operate at a daily rate of 158,800,000 cubic feet and extract liquid products at an average rate of more than 354,000 gallons daily.

Four of the plants are in the Altamont-Bluebell area of Duchesne County. The Greater Red Wash area of Uintah County and the Aneth and Lisbon areas of San Juan County have one plant each.

The four facilities along the Tertiary producing trend in Duchesne County represent a total processing capacity of 87,500,000 cubic feet of gas per day; their present throughput is 59,000,000 cubic feet of gas per day.

Among the four Duchesne County plants two are operated by Gary Operating in the eastern (Bluebell) part of the field complex. The plants are both of the absorption type; each is rated at 20 million cubic feet per day capacity.

One of them in NW¼ sec. 23, T. 1 S., R. 2 W., 6 miles west of the Uintah County line, is running at capacity and producing about 65,000 gallons of liquids per day—40,000 gallons of butane and 25,000 gallons of propane.

The other Gary plant is in NW¼ sec. 5, T. 2 S., R. 3 W., closer to the central area of the field. It is processing only 5,000,000 cubic feet of gas daily and producing about 15,230 gallons of liquids daily, of which 11,230 gallons are propane.

On the Altamont side of the field complex, Shell Oil operates a refriger-

ation type plant that is capable of processing 40,000,000 cubic feet of gas per day but is currently operating at a 28,000,000 cubic foot rate. It is in NW¼ sec. 34, T. 1 S., R. 4 W., about 4 miles west and a little north of the nearest Gary plants. Liquid production at Shell's plant is 76,000 gallons per day, of which 50,000 gallons are propane and 26,000 butane.

Koch Exploration has the westernmost plant in the general area of the Altamont-Bluebell complex in NE¼ sec. 4, T. 3 S., R. 6 W., just north of the Cedar Rim part of the complex. It is a smaller refrigeration type plant with a capacity of 7,500,000 cubic feet per day, but now it is processing about 6,000,000 cubic feet. Liquids extracted there amount to about 15,000 gallons daily.

In all, the four Duchesne County plants along this Tertiary trend with their 87,500,000 cubic feet per day combined capacity and 59,000,000 cubic feet throughput produce 171,230 gallons of liquids daily. This includes 92,230 gallons of propane, 74,000 gallons of butane, and 5,000 gallons of gasoline. All the gasoline is produced at the Cedar Rim plant.

The Red Wash plant in NW¼ sec. 24, T. 7 S., R. 23 E., Uintah County, is operated by Chevron Oil Company. It is a refrigeration type plant with a capacity of 38,000,000 cubic feet per day, but now it is processing about 16,000,000 cubic feet per day and producing 4,000 gallons of gasoline daily with no other liquids.

The Aneth area plant in NW¼ sec. 6, T. 41 S., R. 24 E., San Juan County, is an El Paso Natural Gas operation—an absorption type plant with 110,000,000 cubic feet per day capacity that now processes only 22,300,000 cubic feet per day. It produces 11,230 gallons of propane and 79,380 gallons of other miscellaneous products for a total of 90,610 gallons per day.

Lisbon field is served by a refrigeration type plant of 80,000,000 cubic feet daily capacity. The plant is operated by Union Oil of California and is located in the center of sec. 22, T. 30 S., R. 24 E. It is processing 61,500,000 cubic feet of gas per day. Extracted liquids total 92,300 gallons, including 46,500 gallons of propane, 31,500 gallons of butane, and 14,300 gallons of gasoline.

Oil and Gas Hearings

Several developments affected the Utah Division of Oil and Gas Conservation during the year. The Utah legislature passed the Mined Reclamation Act which assigned responsibilities for mining operations to this division and changed its name to the Division of Oil, Gas and Mining of the Department of Natural Resources. This act became effective on July 1, 1975. Early in the year the Division modified and extended orders to cover additional lands at the eastern end of the Altamont-Bluebell field at the request of Shell Oil. In April, the Division waived no-flare regulations with regard to two wells in Duchesne County at the request of Mapco Incorporated. A six-month extension of gas flaring regulations at Altamont-Bluebell was approved in May and again in November. The Division requires a review of the extension order every six months.

Oil and Gas Leasing

Discovery of the Pineview oil field, Summit County, and indicated oil discoveries in adjacent southwest Wyoming greatly stimulated oil and gas leasing. Amoco Production acquired a 107,000 acre lease in the overthrust belt area of eastern Rich County, along the Wyoming state line north of the field. Lands embraced in the lease are in townships 5-9 N., ranges 5-8 E. Three-fourths of the minerals were leased from Deseret Incorporated; the remainder were leased from other companies that had purchased parts of the range land from the Deseret Ranches. Terms of the lease reportedly call for two wells: one a test of Nugget Formation and the other of Pennsylvanian.

Initial phase of exploration on an 80,000 acre leasehold purchased by Patrick Petroleum in northern Rich County was conducted in September. Work included aerial photography, gravity and seismic studies, and possible drilling-site evaluations. The company indicates drilling will be started in 1976.

A Salt Lake City partnership of Vern and Dorothy Jones acquired a combined total of more than 252,000 acres in federal leases in Tooele County

and about 23,000 acres in Box Elder County during the latter part of the year. The Tooele County lands are generally in T. 1 N. through T. 2 S., R. 13, 14, 15, 16, and 17 W., and the Box Elder County lands in T. 2, 3, and 4 N., R. 18 and 19 W.

Lease Sales

The Uintah and Ouray Agency at Fort Duchesne held several lease sales in 1975. In February, the agency recorded bids totaling \$254,766. Chevron Oil paid the high bid of \$307.34 per acre for a 40 acre tract just north of Altamont field production. A sale held in March got an average of \$45.10 an acre for a total bonus of \$1,003,074. Some 22,261 acres were sold with Shell Oil paying the highest bid of \$124.76 an acre for 160 acres of allotted land. Shell also paid more than \$123.00 an acre for nine other tracts. During November, the Uintah and Ouray Agency offered 51,456 acres and received bids on 27,284 acres. Koch Exploration paid \$28.35 an acre for 640 acres, all in sec. 16, T. 4 S., R. 9 W., about 13 miles southwest of Cedar Rim field.

The U. S. Bureau of Land Management held a sale in March, which attracted a high bonus bid of \$103,192. Universal Resources paid the top bid of \$54.99 an acre for 280 acres in the San Arroyo field. The U. S. Bureau of Land Management held another sale in December which got \$146,657 for 17 parcels containing 4,486.66 acres. Top bid at this sale was \$142.60 an acre paid by Reserve Oil and Gas on a tract in Salt Wash field.

The Utah Department of Natural Resources of the Division of State Lands offered 89 tracts containing 67,642 acres in June and another 71 tracts containing 36,590 acres during August. Kissinger Petroleum was high bidder offering \$5.75 per acre for 656 acres about three miles south of Big Indian field in San Juan County. At a lease sale in October conducted by the Division of State Lands, Cities Service Oil paid \$7.00 an acre for 500 acres in sec. 23, T. 6 S., R. 21 E., Uintah County.

OIL SHALE AND OIL SANDS (TAR SANDS)

In eastern Uintah County two oil shale projects based on underground mining and surface processing are in preliminary stages. The mining projects,

one by White River Shale Oil Corporation and the other by The Oil Shale Corporation, eventually will cost \$1.8 to \$2.0 billion and are planned to be in production in the early 1980's. White River Shale Oil Corporation's plans call for a \$1 billion oil-from-shale facility along the White River. Production will be about 100,000 barrels of high-quality synthetic crude oil daily. During 1974, the firm paid \$45 million for a 5,120 acre tract offering by the U. S. Department of the Interior. The Oil Shale Corporation outlined its plans to the Utah Division of State Lands for construction of a 75,000 barrel per day oil shale recovery plant on leases about 35 miles south of Vernal. The project will be completed within ten years and will cost approximately \$600 million. The operation is to produce 100,000 tons per day of shale from a mine 2,000 feet underground. Lands leased from the state include the site for a 19,890 acre-foot reservoir in the valley of Sand Wash to store water pumped from the White River.

Sohio Petroleum, Sun Oil, and Phillips Petroleum propose an oil shale operation on their 5,120 acre tract for which they paid \$75.6 million last year. Soon after the leases were granted by the U. S. Department of the Interior, environmental monitoring, hydrologic studies, surveys of socioeconomic impact on the area, and various other studies were started.

An *in situ* experiment proposed by Western Oil Shale and supported by 10 other oil companies involves mining out underground chimneys for use as retorts. The more than \$400,000 study involves approximately 76,000 acres of oil shale lands in Uintah County.

VTN Corporation of Denver was awarded contracts to install and operate instruments that will monitor all environmental parameters and to conduct detailed exploratory drilling on oil shale tracts in the Uinta Basin. The contract is estimated at near \$6 million.

Three projects in oil sands (tar sands) are also proposed or under way in Utah. Arizona Fuels and Sohio Petroleum have opened a small open pit mine in the southern Asphalt Ridge deposit 7 miles south of Vernal. The U. S. Bureau of Mines conducted its experiment to produce oil from oil sand in place by a technique known as a reverse combustion fireflood. The project produced about 50 barrels of oil from beneath a few acres. The site is about 4 miles west of Maeser, Utah, in the Northwest Asphalt Ridge area. In Wayne County, Oil Development Company of Utah and several cooperating companies propose an experimental fireflood project to recover oil from the White Rim Sandstone (Permian) at depths of 1,400 to 1,600 feet in the giant Tar Sand Triangle deposit. The deposit, containing 12.5 to 16 billion barrels of heavy oil in a reservoir beneath more than 200 square miles, is possibly the largest in the United States. The project has been stalled by environmental and legal disputes.

Geotechnical Evaluation . . .

Cache Valley To Undergo Geologic Study

The Urban and Engineering Geology Section of the Utah Geological and Mineral Survey has chosen the Cache Valley for a geotechnical evaluation of public facilities. The study will concentrate on existing and proposed sites for hospitals, emergency centers, schools, water impoundments, and water and wastewater systems including wells, springs, and treatment plants.

Bruce N. Kaliser, section chief, stated that the study is being made (1) to improve geologic-engineering criteria in choosing sites for public facilities, (2) to trace problems in existing facilities to their cause, (3) to assist political subdivisions where possible with proper geotechnical evidence about future sites, and (4) to show public officials the importance of geotechnical studies.

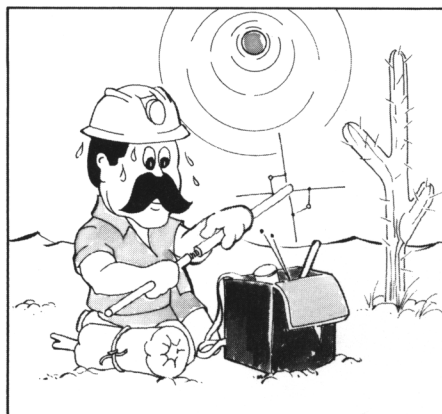
The present study is examining hazards to public facilities from earthquakes. Its objective is to reduce risk economically by providing geotechnical guidelines for careful planning.

Last year UGMS distributed a report on faulting in the Cache Valley, *Investigation and Evaluation of the Northern Wasatch and Cache Valley Faults*, to planners, building inspectors, and elected officials. Along with the report, Kaliser held a workshop on the procedures of engineering geology.

ROCKY RIDGES

ADAPTABILITY IS THE NAME OF THE GAME
FOR SUMMER FIELD WORK . . .

by Greg McLaughlin



Idaho Disaster Shakes Up Utah

The collapse of the Teton Dam in southern Idaho caused many Utahns to take a critical interest in local dam sites throughout the state. For many people the June 5, 1976, disaster compromised the security of all earthen dams.

Bruce N. Kaliser, engineering geologist at the Utah Geological and Mineral Survey, renewed his plea that the State should have some control over the location and design of water impoundments constructed by the federal government. Kaliser noted that a reservoir of only 20 acre-feet, if poorly placed, could pose a serious risk to life and property. Years ago, Kaliser and William P. Hewitt, the then director of UGMS, advocated that State personnel regularly inspect and report on the condition of dams in Utah.

The failure of the Teton Dam may be a significant forewarning. In June UGMS geologists spotted potential problems in four small municipal reservoirs, and following normal procedure, notified local authorities of the situations. Construction was halted at one site and remedial actions are being taken on the others.

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GUIDEBOOK AVAILABLE

A guidebook for one of the two-day field trips at the Geological Society of America's 1975 Annual Meeting in Salt Lake City, Utah, has been published. *Guidebook to the Cenozoic Structural and Volcanic Evolution of the Southern Marysvale Volcanic Center, Iron Springs Mining District, and Adjacent Areas, Southwestern Utah* by P. D. Rowley and J. J. Anderson is available for \$3.50 from the Gamma Zeta Chapter, Sigma Gamma Epsilon, Kent State University, Kent, Ohio 44292.

PINEVIEW FIELD ACTIVITY BRISK

Pineview, Utah's newest major oil field, had four producing wells on June 30, 1976. Two wells were drilling, and another had just "rigged up" in preparation for drilling.

One deep wildcat was being tested 5 miles southwest of the field. At a total depth of 17,053 feet, this well was testing gas and oil shows that might indicate a second new field in Utah's overthrust belt. Another wildcat had just been started a mile northeast of the town of Coalville.

Production from Pineview field has averaged about 1,200 barrels per day and is limited by the capacity of trucks moving the crude oil to market.

Overall Drilling Decline In Utah

Fifteen drilling rigs are at work in Utah, two less than a month ago and significantly less than the 26 active rigs at work this time a year ago. Petroleum Information Corporation reports the rig count, compiled each week by Hughes Tool in conjunction with the Independent Association of Drilling Contractors, is climbing steadily in the rest of the Rocky Mountain states. Active rigs numbered 216 on July 12, nine more than in the previous week but still 31 below the 247 figure of a year ago. However, the rig count is up by 61 from the year's low of 155 on April 19. As of July 15, 1976, operators completed 71 wells in Utah, a drastic decline from the 113 wells completed during the same time a year ago.

UTAH GEOLOGICAL AND MINERAL SURVEY SURVEY NOTES

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